



ON-GOING MEASUREMENTS :

- M_** 5 offshore Moorings
- S_** 3 Shipvisits per month
One annual large scale cruise
- R_** 2 radars
- A_** 3 Atmospheric monitoring
- F_** Active Provbiofloats
- G_** 2 gliders transects
- B_** 2 Meteo-France surface buoys



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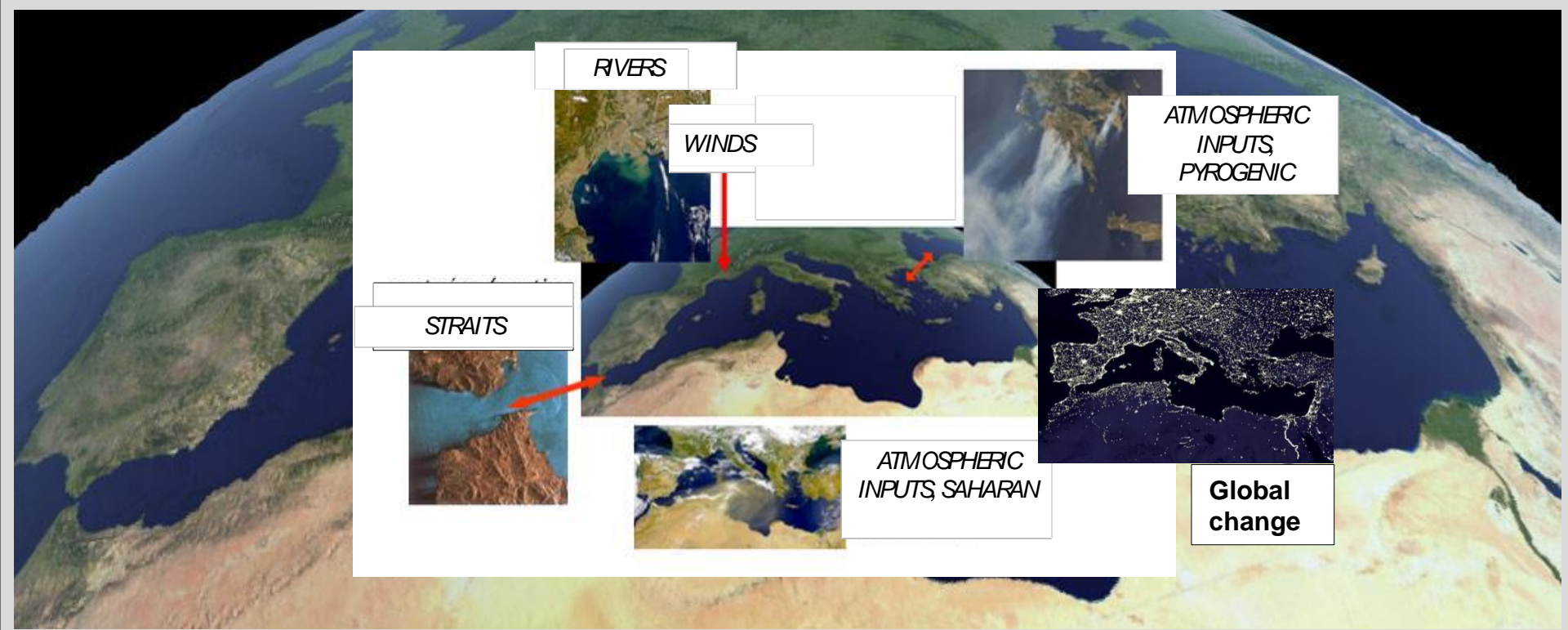
- 1. MOOSE history**
- 2. MISTRALS Program**
- 3. MOOSE implementation**
- 4. Some (interesting) results**
- 5. Data management and data flow**
- 6. MOOSE and the MSFD**
- 7. Two open questions for the future in the global Mediterranean context**

- 1988 - ...: Offshore fixed point observations at the “**Service National d’Observation**” **DYFAMED** and monthly R/V surveys
- 2000: Start of a (slow) national process toward an in-situ operational observing system → Not yet established as an overall system !
- 2005: Large national Consultation for multidisciplinary research coordination in the Mediterranean area → **MISTRALS** meta-program
- 2008: CNRS top-down process for an **multidisciplinary Integrated Ocean Observing System for Long Term observation** for MISTRALS and **Operational oceanography** → **MOOSE**
- 2010 - 2014: **MOOSE** labeled by **ALLENVI** for (4)5 years and established at CNRS
- 2011: Funding of MISTRALS programs (HYMEX, MERMEX, ...) starts
- 2015: Assessment by ALLENVI and proposal for a 2nd MOOSE contract period
- **Strong national research context → Challenge for MOOSE for future integration at the Mediterranean / European levels**



Mediterranean Integrated STudies at Regional And Local Scales

The Mediterranean Basin
A Unique coupled system between land, ocean,
atmosphere and societies



MISTRALS = “A decade to observe, understand, and predict the livability of the Mediterranean area over a century”



MISTRALS thematic programs for an integrated vision of the Mediterranean system



HyMeX

- **Hydrological cycle** in the Mediterranean eXperiment
- Understanding the global water cycle, extreme events and climate change

ChArMeX

- **Chemistry-Aerosol** Mediterranean eXperiment
- Changes in atmospheric chemistry, effects of fires and desertification, impacts on regional climate and bio-geo-marine chemistry

MerMeX

- **Marine Ecosystem** Mediterranean eXperiment
- Response of ecosystems to human activities and climate change, biogeochemistry and pollution

PaleoMeX

- **Paleo Climatology** Mediterranean eXperiment
- Relations Climat-Human-Environment during Holocen

SICMed

- **Continental Surfaces** in the Méditerranéan
- Evolution of eco-anthroposystems –agriculture, climate change-

TerMeX

- **Terra Solid Earth** Mediterranean eXperiment
- Mediterranean geo-dynamics, risks et resources

BioDivMex

- **BioDiversity** of the Mediterranean eXperiment
- Biodiversity evolution

SocMed

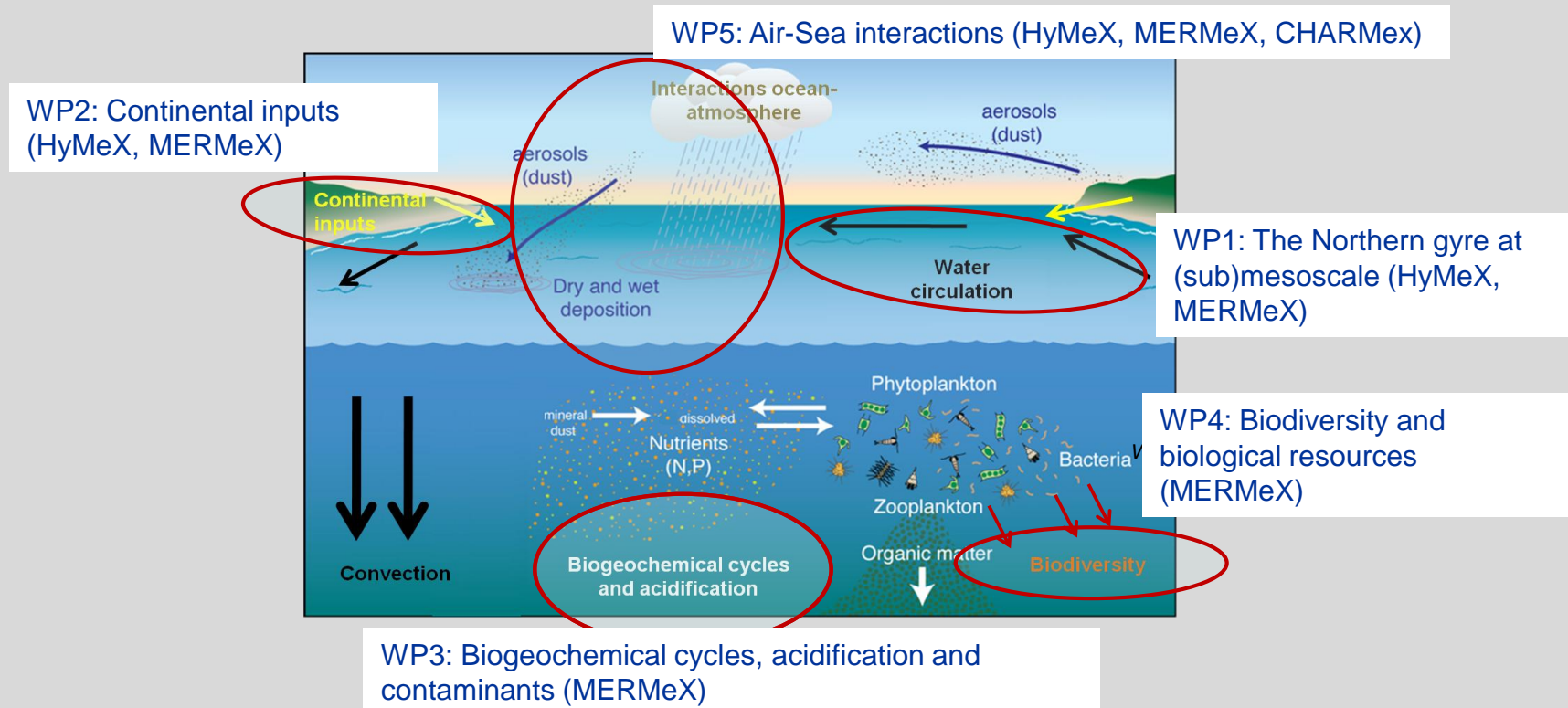
- **Societies** in the Mediterranean
- Relationships between societies and environment

Multidisciplinary
observatories
MOOSE, O-LIFE, ...

« Shore-Med »
Interdisciplinary
program

MOOSE principles

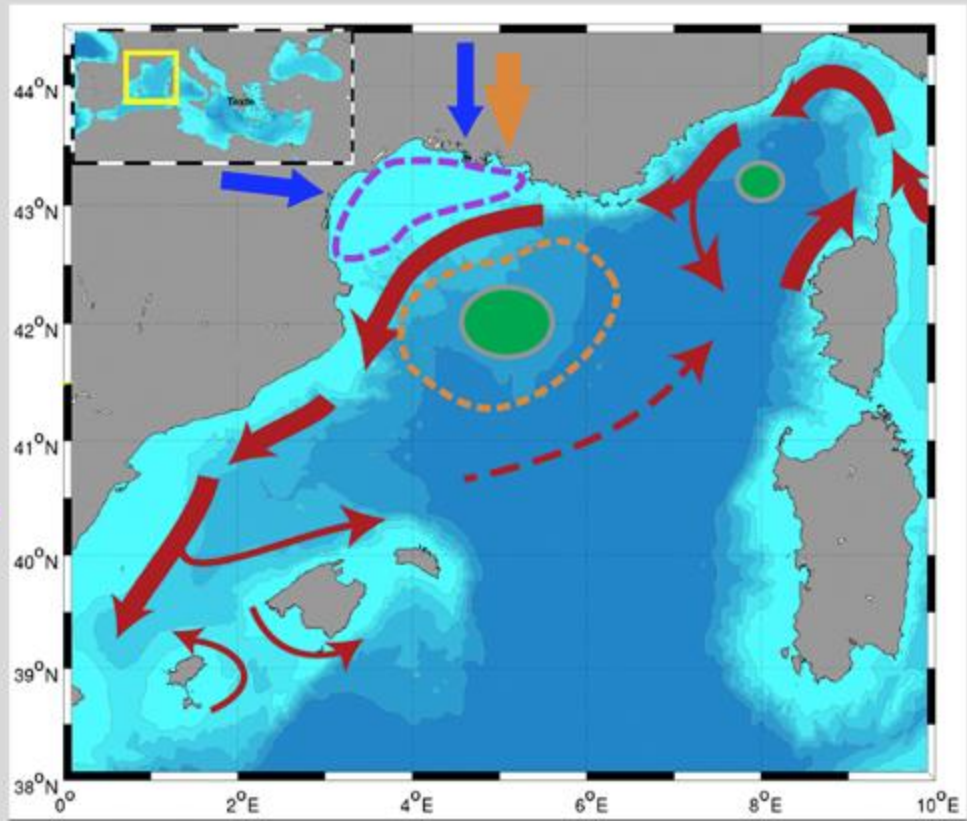
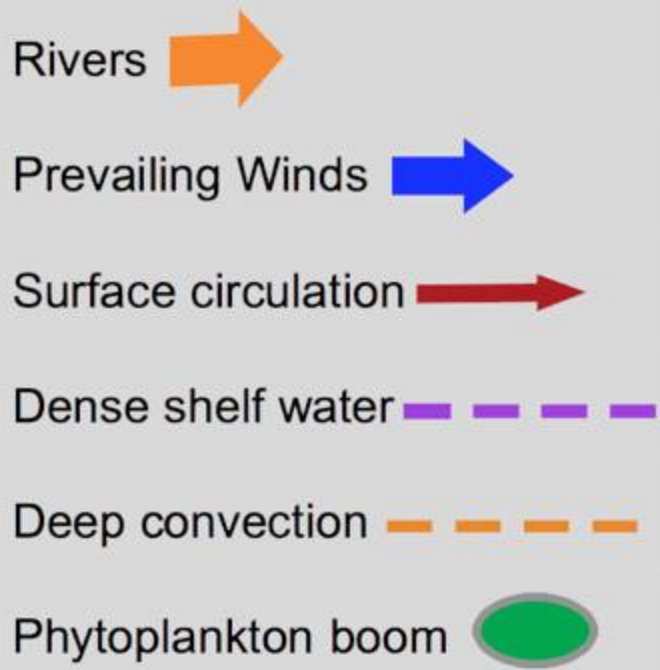
- Focused on **fundamental scientific questions** raised by MISTRALS programs and **societal problems**
- **Multidisciplinary long term observations** of the ocean interior and its interfaces (atmosphere-ocean, land-ocean) → **Organized along 5 work packages** and a modeling transverse action
- Based on **existing infrastructures** as much as possible
- Operated in a collaborative way by all committed institutions: Research and operational agencies, Universities and possibly other regional stakeholders → **Sharing of resources** for fields operation, in the laboratory (analysis) and for data management → **Avoid duplication !!**
- Right **balance between stability of the system and Innovation**
- Provide maximum **benefit to all users from any single observation** (research, operational, society)



MOOSE sampling strategy

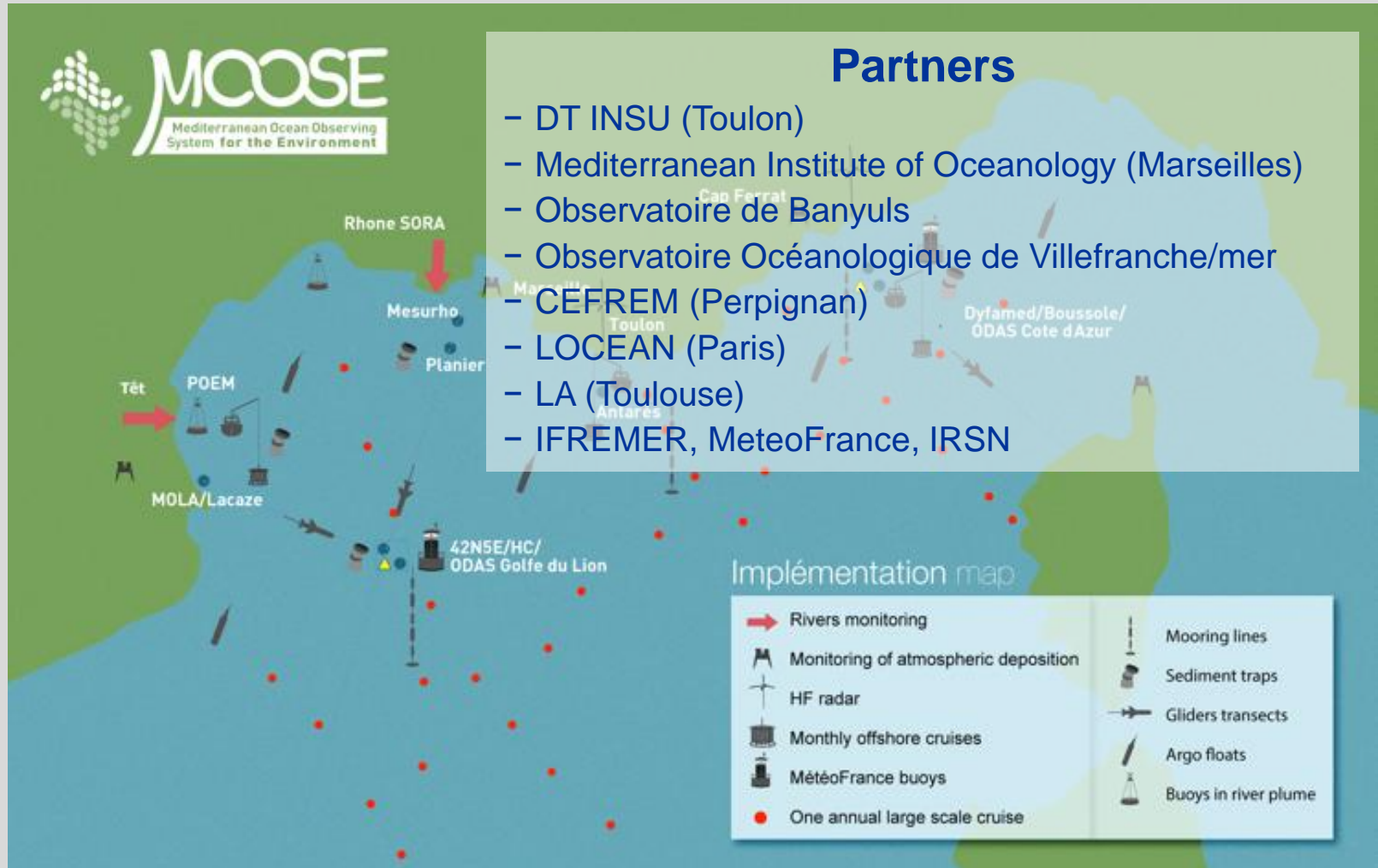
1. consider the **land – coastal zone - open ocean** continuum in relation with the **atmosphere** over **the whole range of space and time scales**
2. consider the **Mediterranean Sea** with a focus for the French community on the **North Western basin**. Well known area and where **a large variety of forcings and ecoregions** are present: Northern current, dense water formation, spring phytoplanktonic blooms, ...)

➔ **Need for global obs. by other systems**



MOOSE implementation

A **multi-site / multi-platorm** organization of **continental, coastal/shelf** and **deep-sea** fixed point, (semi)lagrangian platforms and R/Vs , including HF radars

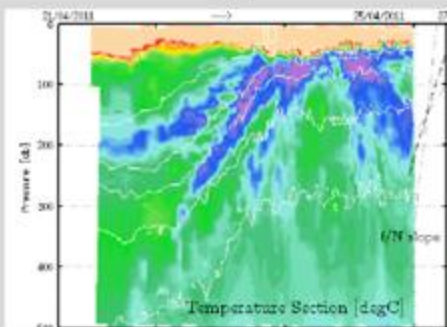
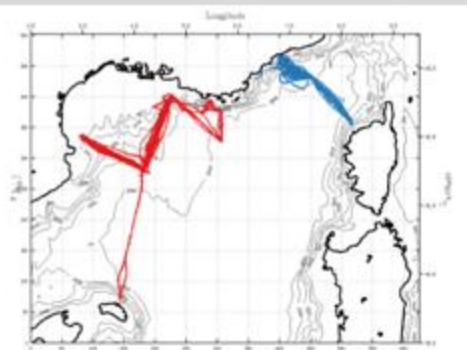


WP1: Circulation in the NW Med

Gliders /floats

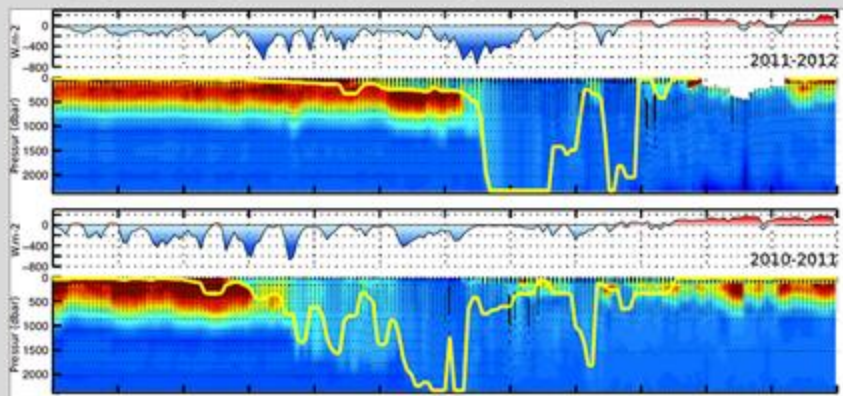
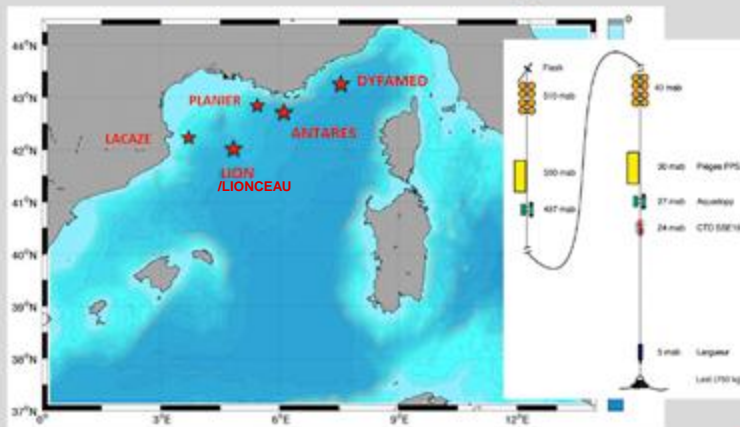


More than 12 000 profiles since 2010



And monthly / annual R/V surveys

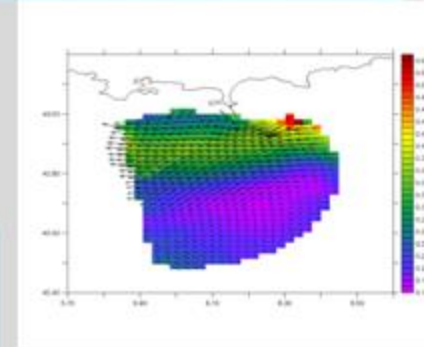
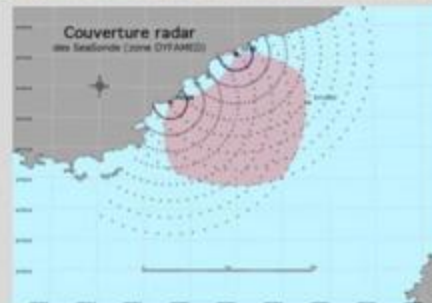
6 offshore Moorings



Water masses evolution – current variability
 Winter convection - Shelf dense water
 Eddies –mesoscale features - instabilities
 Vertical mixing - Coastal/offshore exchanges

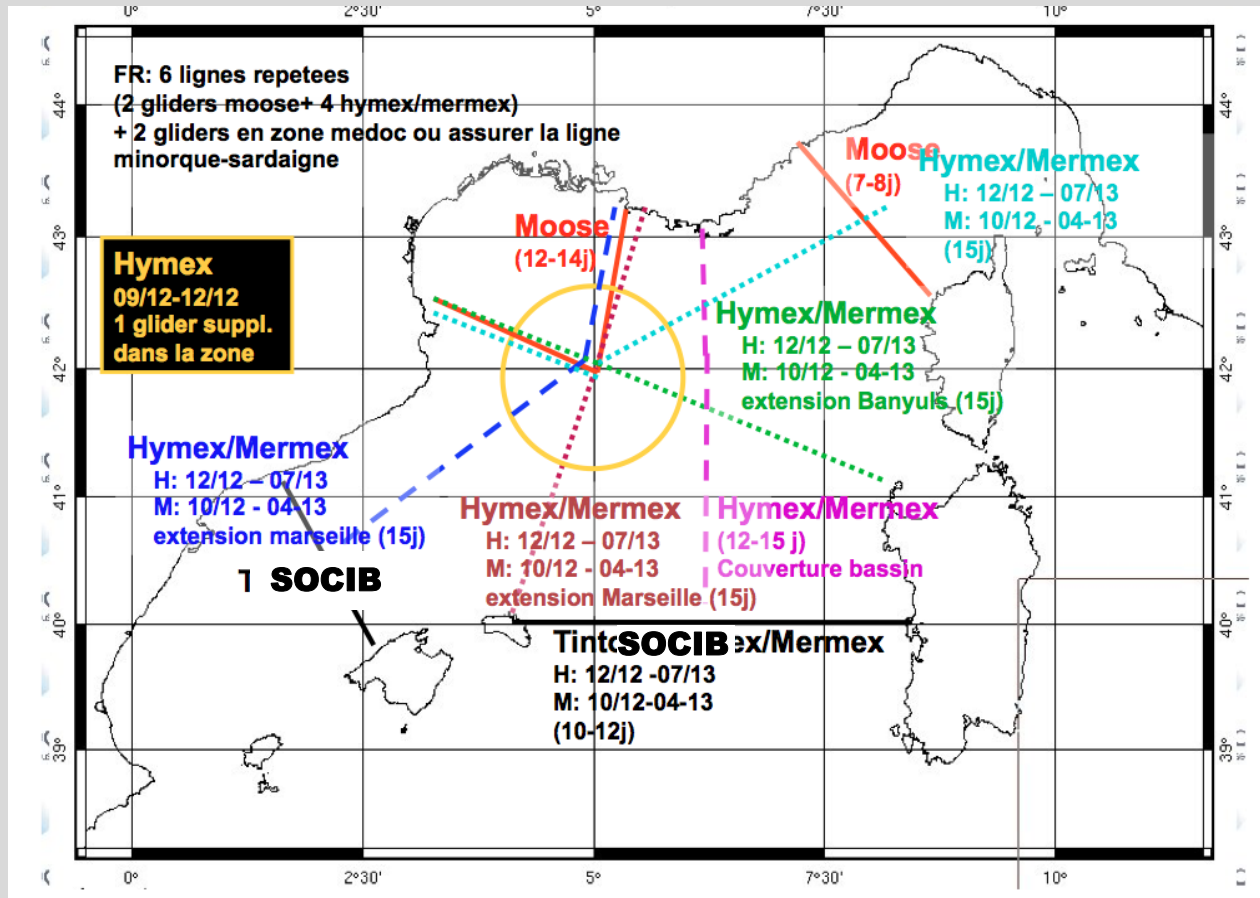
Available data : 2010 -2013

2 HF Radars Toulon - Nice



Start in 2012

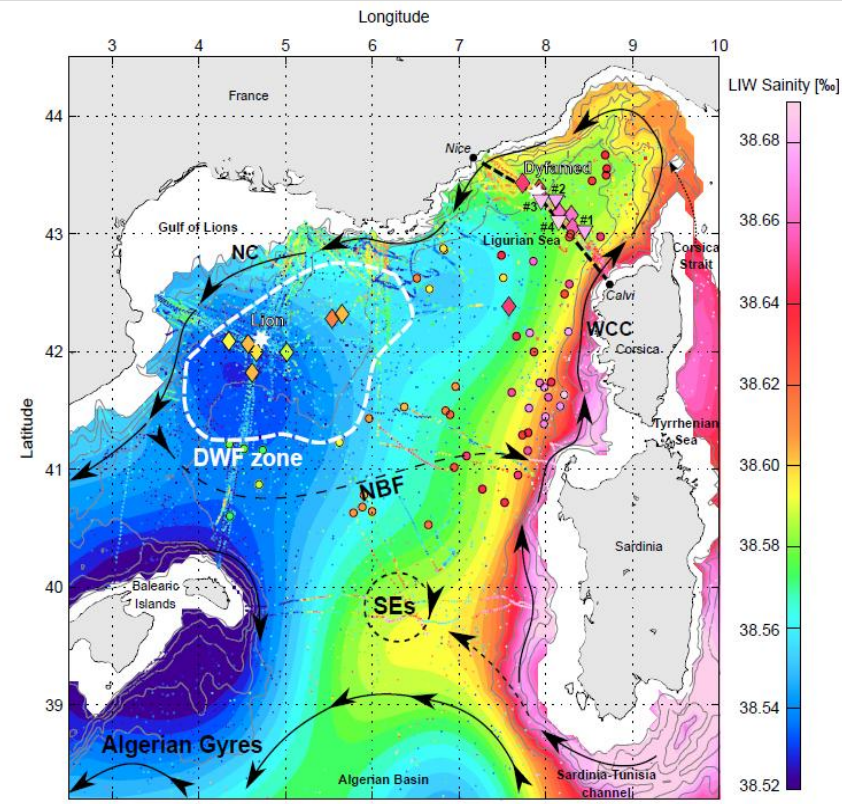
MOOSE and SOCIB support HyMeX / MERMeX: Glider strategy



Long term Observing Period (2010 - ...) by MOOSE and SOCIB complemented by HyMeX/MERMeX funded glider during the 2012 – 2013 Special Observing Period

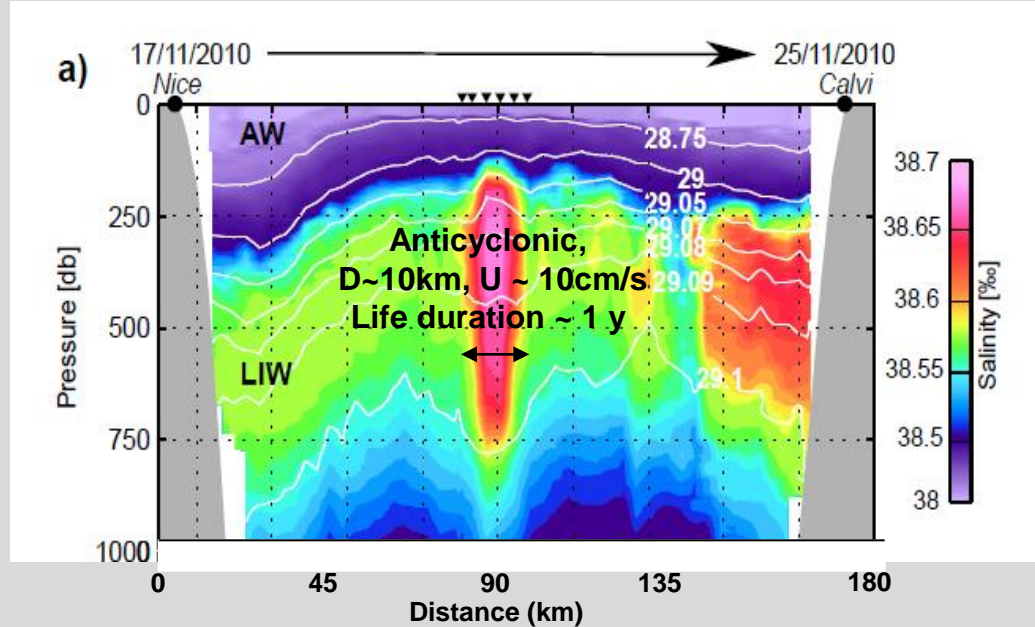
One major research results from WP1 on Submesoscale Coherent Vortices

- Multiplatform T and S profiles (Ships, moorings, profiling floats, gliders)
- Multiscale detailed analysis from large (100km) to small scales (1km)



Objective analysis at LIW depths

- Diamonds, triangles = actual SCVs,
- Circles = candidats

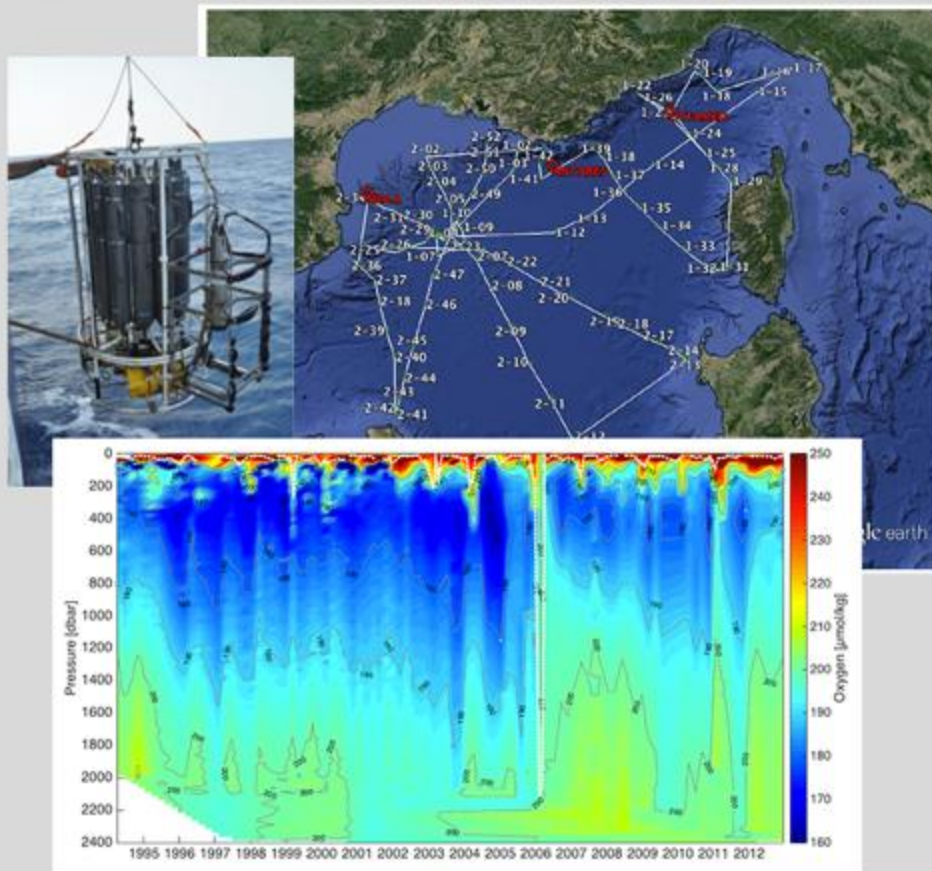


→ Shows the major role of SCVs at large scale

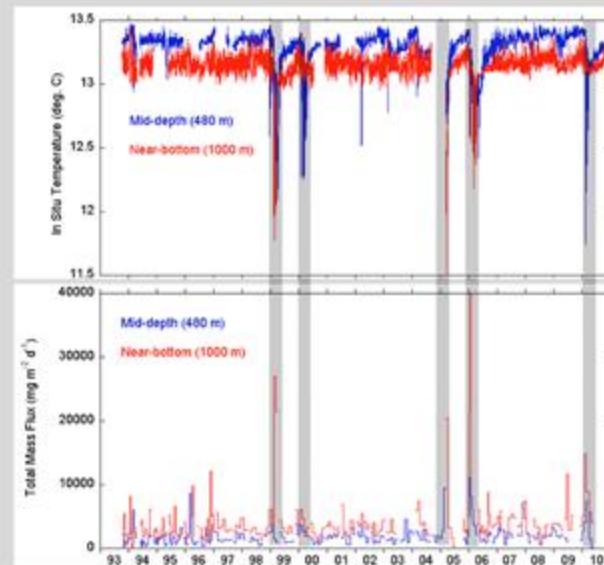
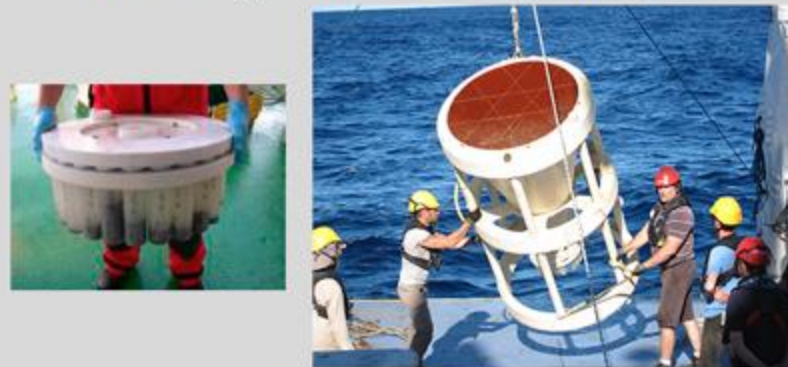
- Preconditioning for convection in the GoL
- Spreading of LIW to the ocean interior
- Spreading of newly formed WIW, mode and deep waters

WP3: Biogeochemical cycle, acidification and contaminants

3 monthly cruises – One annual cruise
CTD-UVP Profiles and water collection



4 mooring with sediment traps



Budget of major elements - CO₂ and O₂ evolution
Bloom dynamics – Biological structure - export production

Available data : 2010 -2013

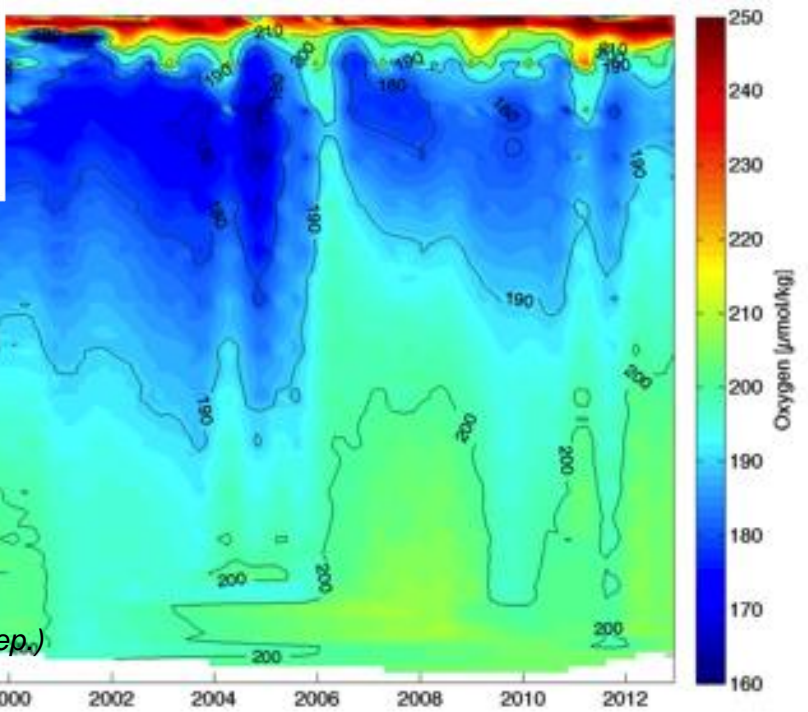
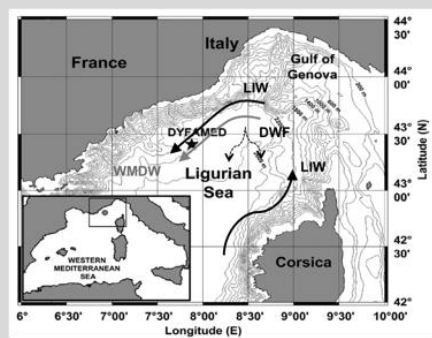
WP3: Oxygen ventilation in the NW Med

O2 minimum near the LIW. Oldest water in the WMED (biological utilization > O2 replenishment) observed over long time series DYFAMED

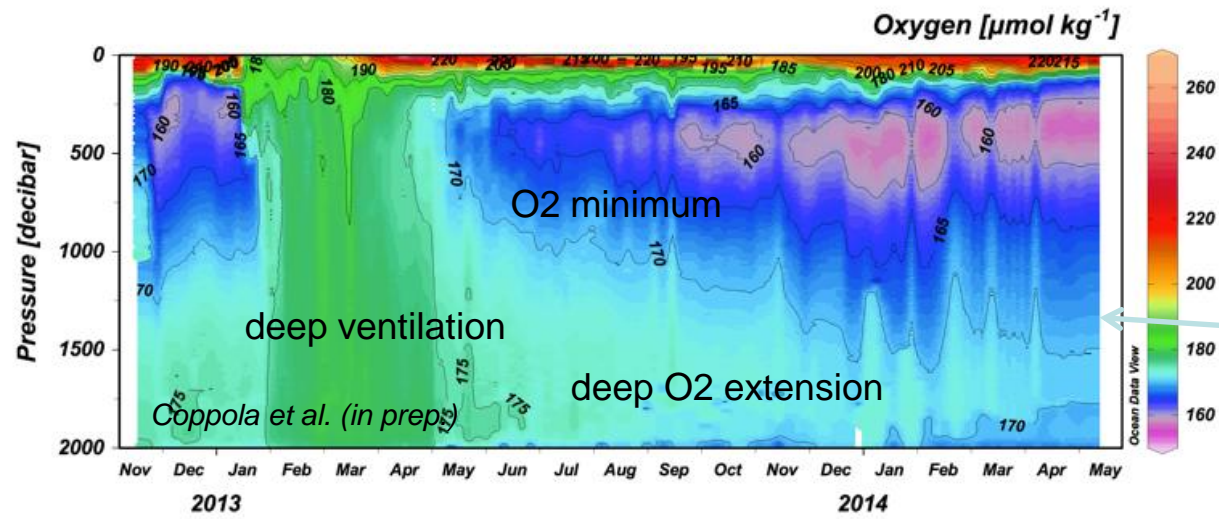
Higher O2 content in deep water. Large bottom waters ventilation (apparition of new WMDW)

Spatial extension through Argo floats and glider deployment

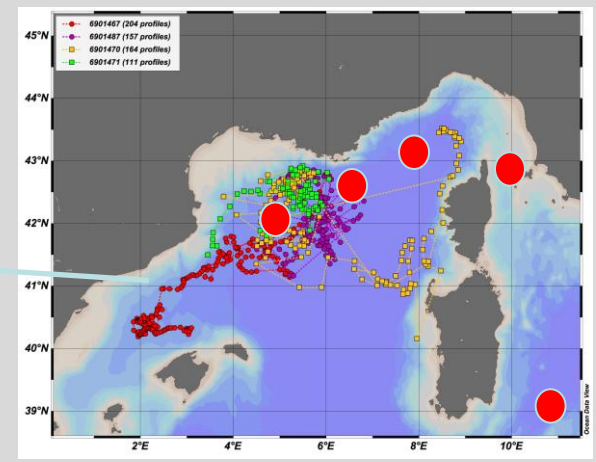
Recent O2 implementation on moorings (JERICO, FIXO3, EMSO) ●



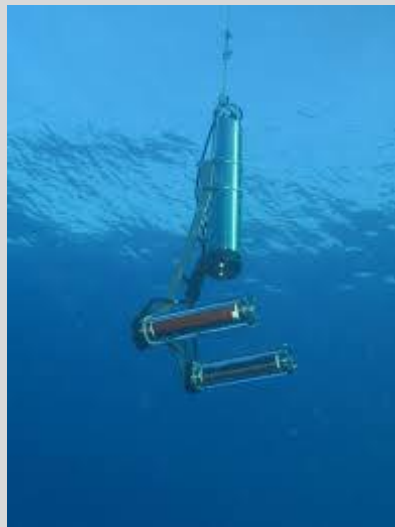
Coppola et al. (in prep.)



Coppola et al. (in prep.)

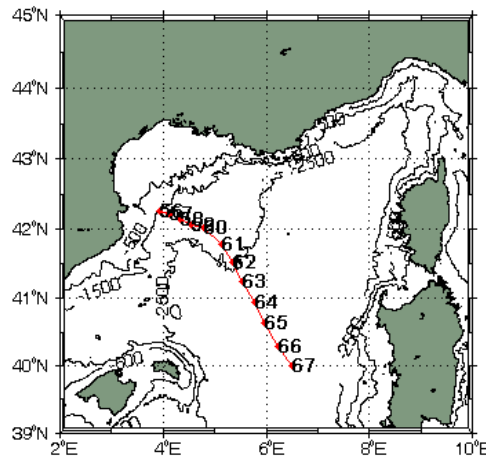


- Particulate size abundance (50µm-few mm)
- Zooplankton identification by imagery (> 60µm)

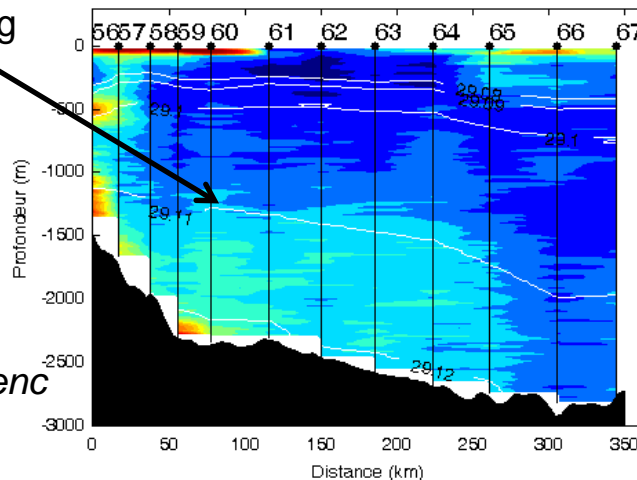


UPV5 from Hydroptic
Operated on monthly
and annual survey
since 2012

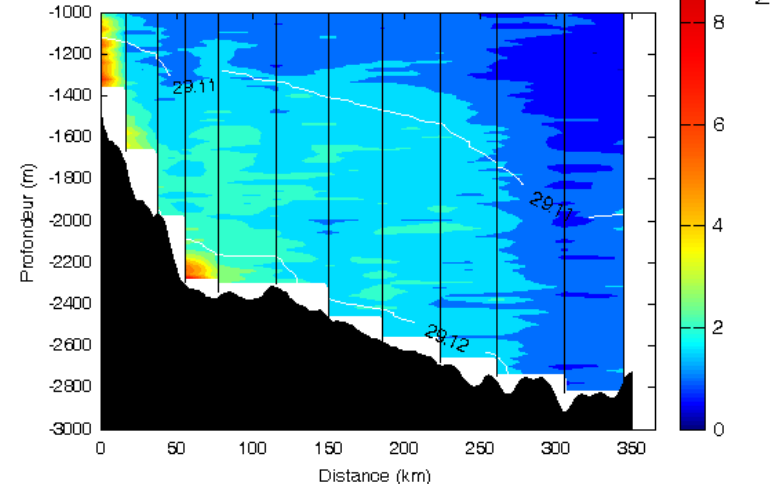
MOOSE-GE2012 transect



PROFIL PARTICULAIRE [200 µm à 500 µm]
0 à -3000 mètres



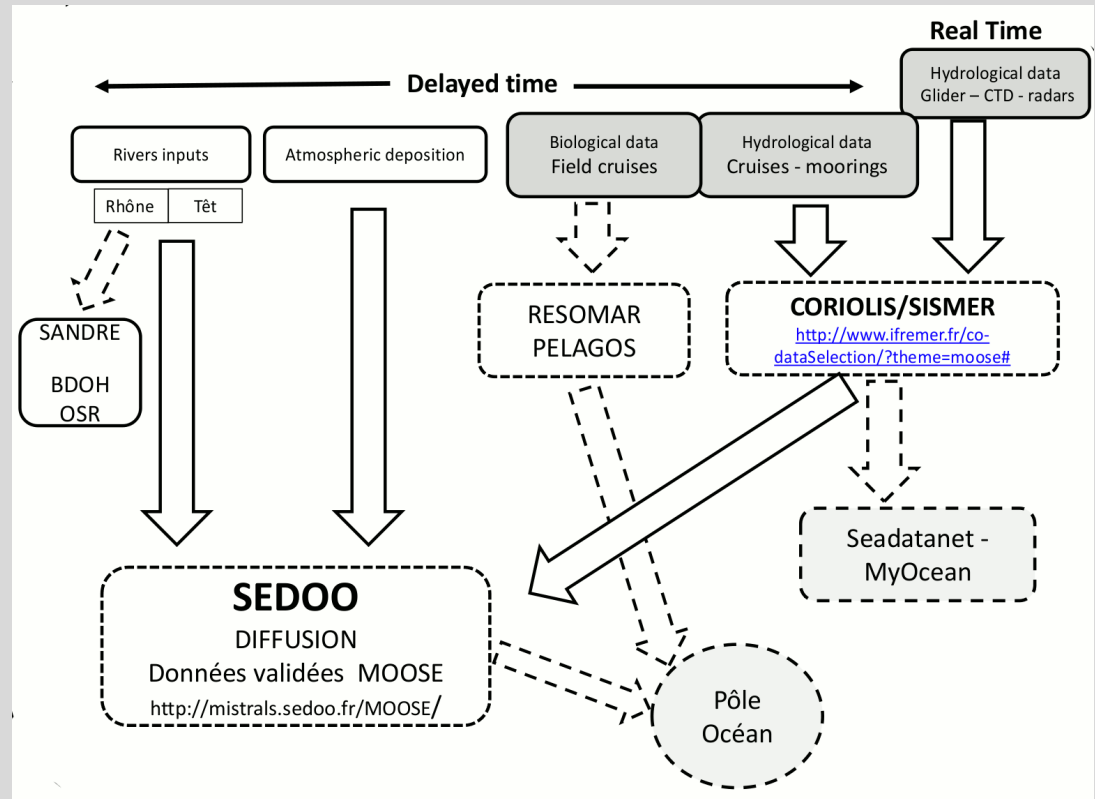
PROFIL PARTICULAIRE [200 µm à 500 µm]
-1000 à -3000 mètres



Particles plume
from cascading
and sediment
resuspension

L. Guidi, S. Ramondenc
(unpublished)

1. (almost fully) Open data policy
2. Overcome the national fragmentation → Choice of the SEDOO final repository (Mistrals policy)
3. Manage different data flows according to real / delayed time
4. Each data flow relies on quality control already established procedures
5. Develop Quality control procedure when needed (e.g. in-situ “color” parameters)



- Need for highly qualified personnel time (from technician to scientific Pis)
- Endless effort to fight against fragmentation: systems (national / European) > individuals > robots !!

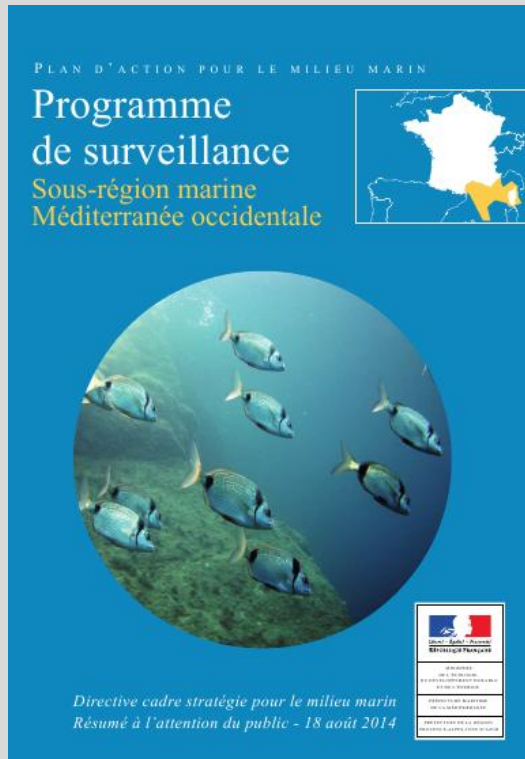
MOOSE and the MSFD first cycle

GES



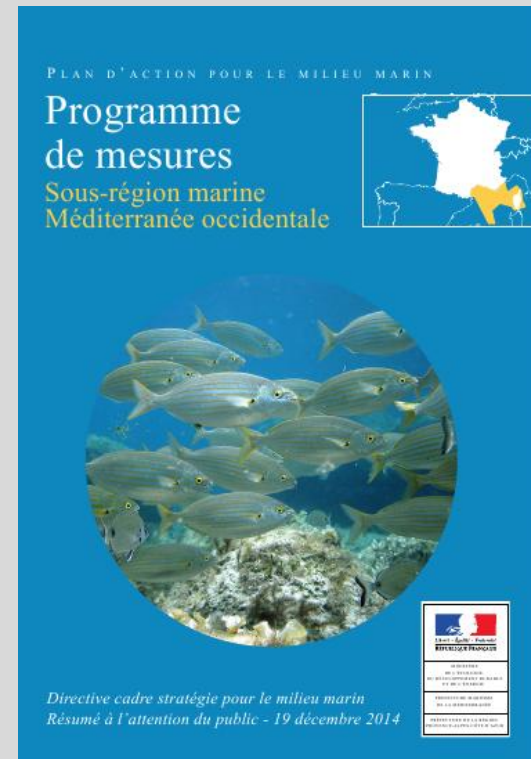
MOOSE provided expertise for Nutrients

Monitoring Program



MOOSE data flow exploited for descriptors 4, 5, 7 and 8. But not in charge of any reporting activity

Program of measures



2015: To be done

➔ Major challenge for MOOSE for the next contract ALLENVI period (2016-2019): To provide expertise on extension and spatial/temporal sampling for the monitoring ➔ New Transverse action in MOOSE

Observing Systems in a “Territorial” sea

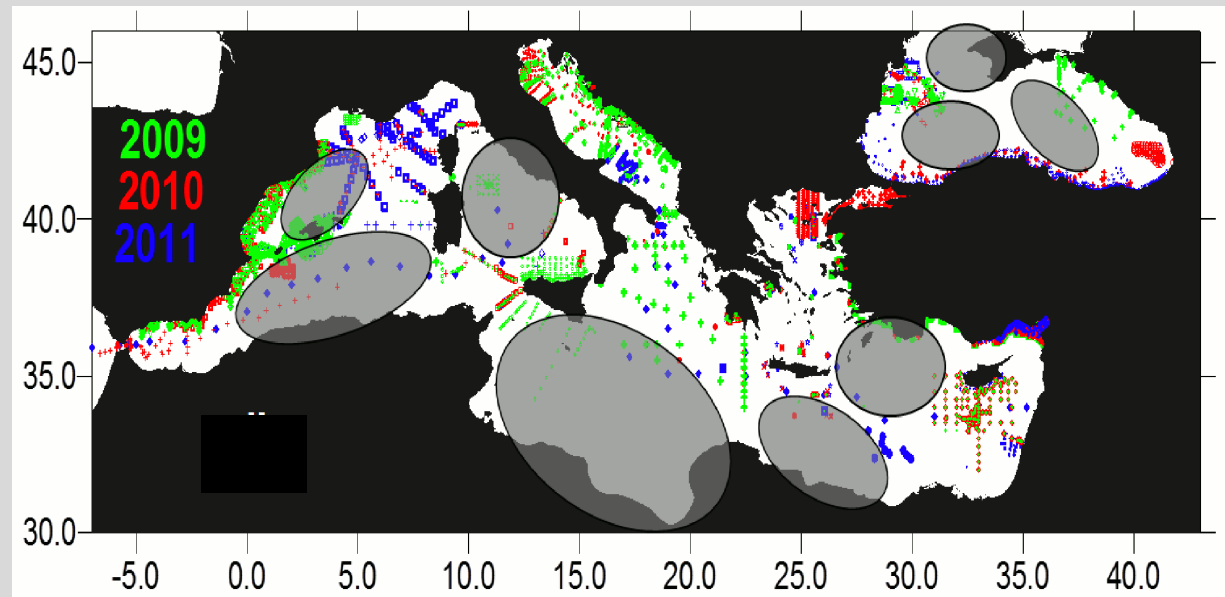
- Most Med. countries have declared EEZs
- If all declared → No more “High seas”

Obs. System = governance, data management policy, long term commitment, ...



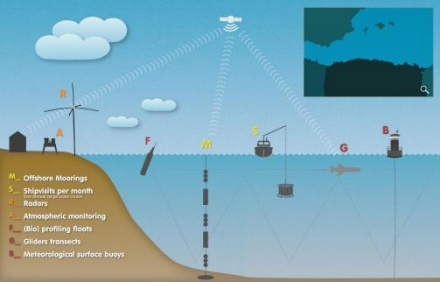
- Established OS: CYCOFOS, MOOSE, POSEIDON, RITMARE, SOCIB
- Starting or in progress: O-LIFE (Lb), RITMARE (It), SOMBA (Al), TSELOS (Tu)
- Different drivers: Op. Ocean. oriented or research oriented
- Different histories, organization and levels of implementation
- ✓ All rely on European Research Infrastructures: EuroArgo, EMSO/FixO3, GROOM, ...
- ✓ Similar data management: all rely on National/European systems (Mycean for RT, Seadatanet/Emodnet for DT and banking)
- ✓ Linked to Operational forecasting systems
- ✗ **No real “core parameters” based on (ecosystem) Essential Ocean Variables**
- ✗ **No common sampling strategies nor analysis methodologies**

- ✓ Most OS have a R/V component; Mostly coastal or large transects
- ✓ Sustainability
- ✗ Large gaps including in Northern waters
- ✗✗ No coordination



- R/V surveys will remain necessary:
 - Numerous core parameters not accessible by profiling floats/gliders
 - High accuracy → Calibration and ground truth
 - Whole water column > 1000 (gliders) or 2000m (Argo)
- Challenges for coordination and collaboration
 - To increase the value of each Euro spent nationally on R/V operating budgets
 - To jointly collect data for research purposes
 - To jointly collect data required by legal obligations (MSFD, CFD ?)
 - To jointly provide support and expertise for gaps areas ; capacity building
 - And, let's dream: Diplomatic clearance (UNCLOS Article 247)



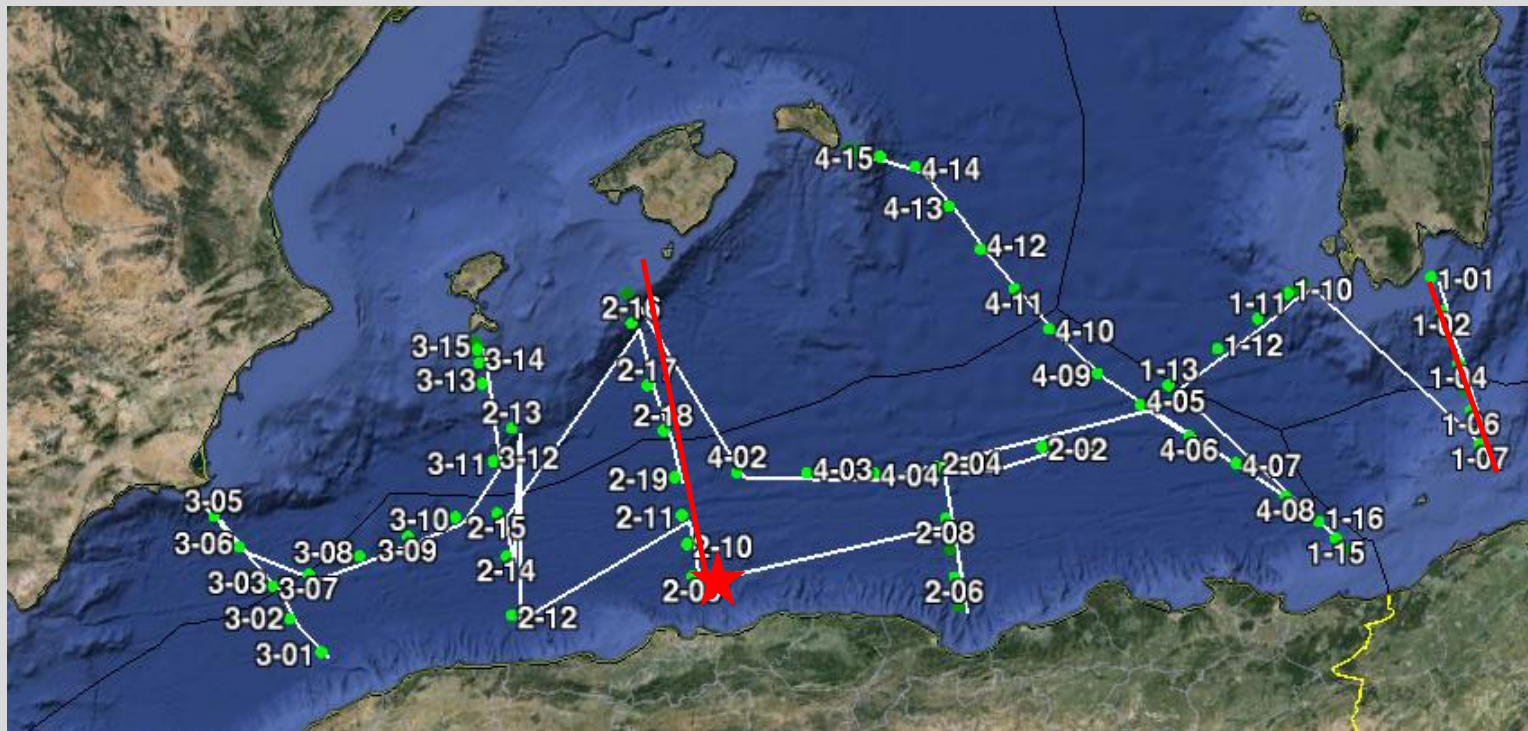


SOMBA

System Observing Marine in the Basin Algerian



- ✓ Starting co-construction effort with Algeria, France, Italy and Spain for SOMBA
- ✓ Achieved in 2014: R/V cruise , 2 gliders lines (PERSEUS/JERICO TNA), 1 mooring, 2 co-badged PhD started with Algerian students
- ➔ Capacity building is crucial
- ➔ Many uncertainties and an endless long term bottom up/top down effort



An integrated network for long-term mediterranean observatory



Thank you for your attention !

ACTUALLY ON-GOING MEASUREMENTS :

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TAKING THE PULSE OF THE NW MEDITERRANEAN SEA

MOOSE reinforces the French scientific community on the NW Mediterranean site, emphasizing its multidisciplinary to mobilize it on a thematic continuum from coastal to offshore regions.

In this context, MOOSE aims to deliver time-series of data to anticipate the behaviour of this marine ecosystem from an interdisciplinary analysis conducted during the next decades.



Land/ocean interactions: rivers inputs

Têt



Daily collection
Flood events

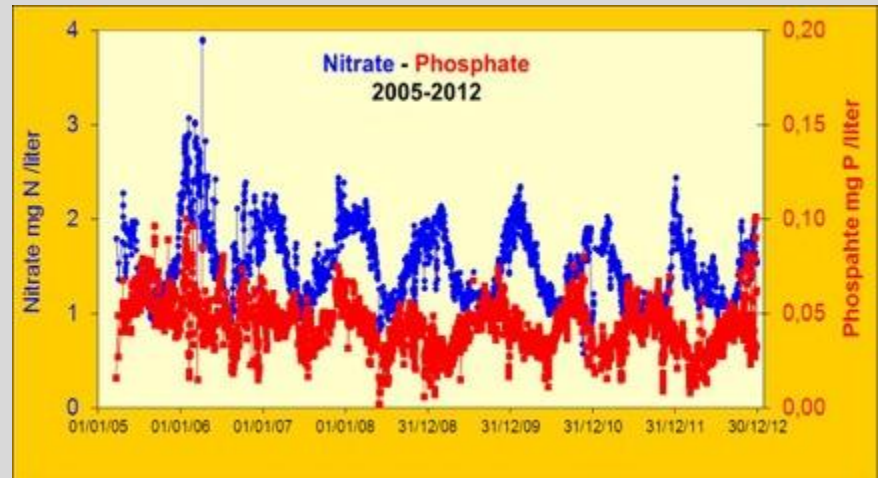
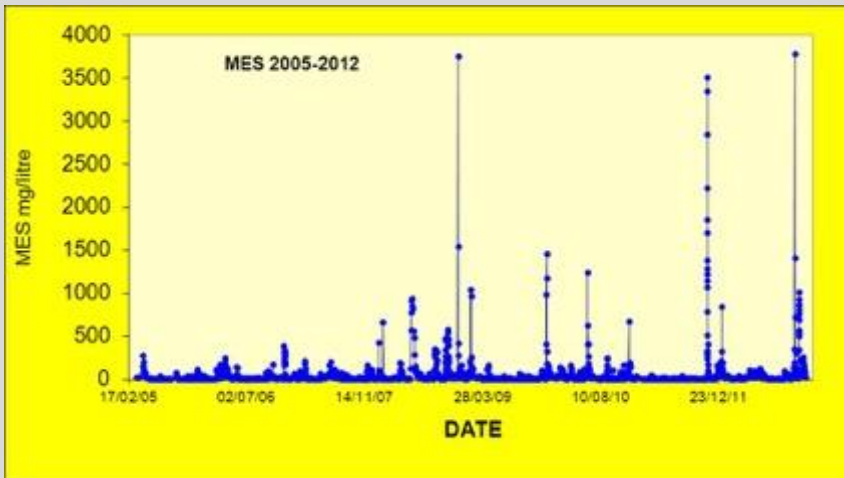


Rhône



Biogenic elements: C,N,P, Si

Trace metals: Ag, Be, Cr, Cu, Fe, K, Li, Mg, Mn, Ni, Pb, Ti



Annual inputs – seasonal variability - impact of flood events - Stoichiometry ratios

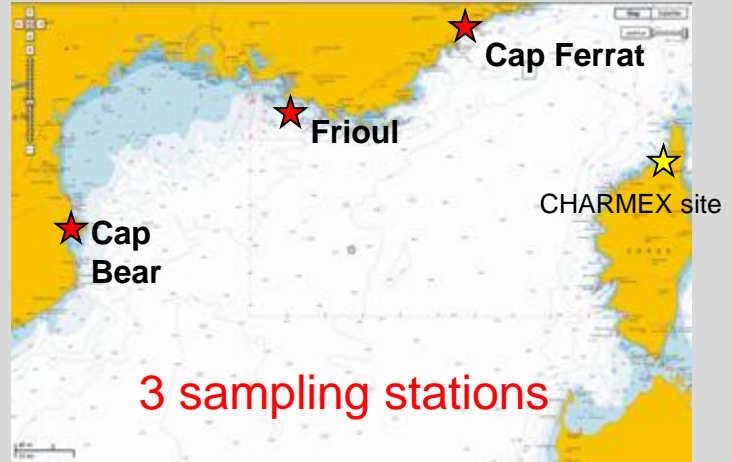
Available data : 2010 -2013

Atmosphere/ocean interactions

Atmospheric deposition

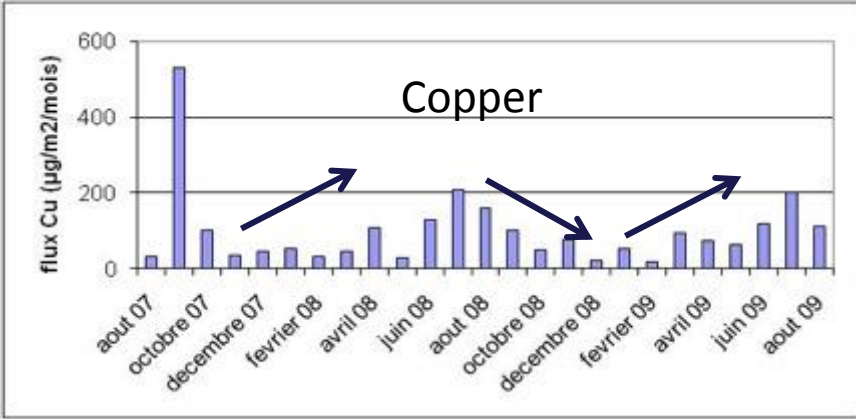
Equipment = MTX-Italia collector

Dry deposition: two weeks
 Wet deposition: rain event



Parameters

- Particulate and soluble fractions - mass flux
- Biogenic elements (C/N/P/Si)
- Trace metals (Ag, Cr, Cu, Fe, Zc,K, Mg, Mn, Ni, Pb)



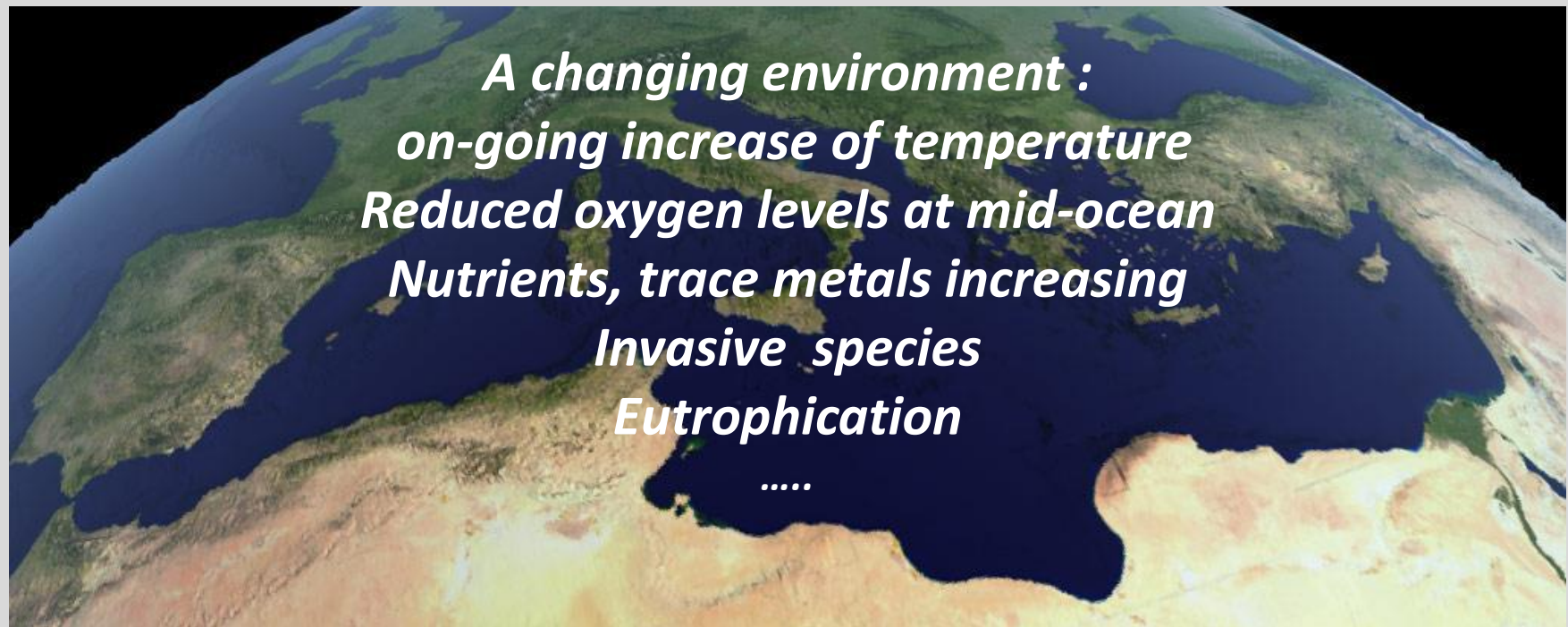
Annual inputs – seasonal variability - saharian events - Stoichiometry ratios - fertilization effects

Available data : 2010 -2013

The scientific issues in MOOSE

Subject to increasing anthropogenic constraints, Med Sea is now threatened both in terms of the ecological balance and of its biological resources and water systems.

In spite of intensive research efforts undertaken in the Mediterranean Sea over more than a century, an integrated view of its evolution still lacks.



Rapid and significant evolution is suspected in response to climate change and human activity

MOOSE OBJECTIVES

Historical data are precious and useful but not enough detailed

Understanding human impact on the marine environment needs accurate and integrated data from long-term observation.

In fact, the ocean is critically under-sampled both in space and time.



These facts have led the French organisms INSU and Alliance Allenvi to build a significant multidisciplinary program to cope with the challenges described above.

The MOOSE strategy

Detecting changes implies monitoring

Monitoring is a real scientific activity that requires an adapted strategy sustainable in operational fashion

- **PERMANENCY OF SAMPLING**
- **KEY SITES**
- **SIMPLICITY OF LOGISTICS – INSTRUMENTATION**
- **STABLE ANALYTICAL PROCEDURES**

The real challenge for MOOSE was to use and integrate classical and new technologies to systematically monitor and resolve the variability at different spatial and temporal scales: regional - sub-basin -seasonal - interannual.

Selected key control sections and sites for routine monitoring by MOOSE has been conducted in the framework of Mistrals program and more specifically according to the operations : HYMEX/MERMEX/CHARMEX

LONG-TERM OBSERVATION

